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(71) Applicant (*for all designated States except US*): **CAMERON INTERNATIONAL CORPORATION** [US/US]; 4646 W. Sam Houston Parkway North, Houston, TX 77041 (US).

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **VYAS, Manish** [US/US]; 8526 Bright Grove Court, Houston, TX 77095 (US). **REID, John** [GB/GB]; Eastlady Field Cottage, Balruddery, Invergowrie, Scotland DD25LG (GB). **DONALD, Ian** [GB/GB]; Ramstone Mill House, Monymusk, Inverurie, Aberdeenshire, Scotland AB51 7JB (GB).

(74) Agent: **SWANSON, Tait, R.**; Fletcher Yoder, P.o. Box 692289, Houston, TX 77269-2289 (US).

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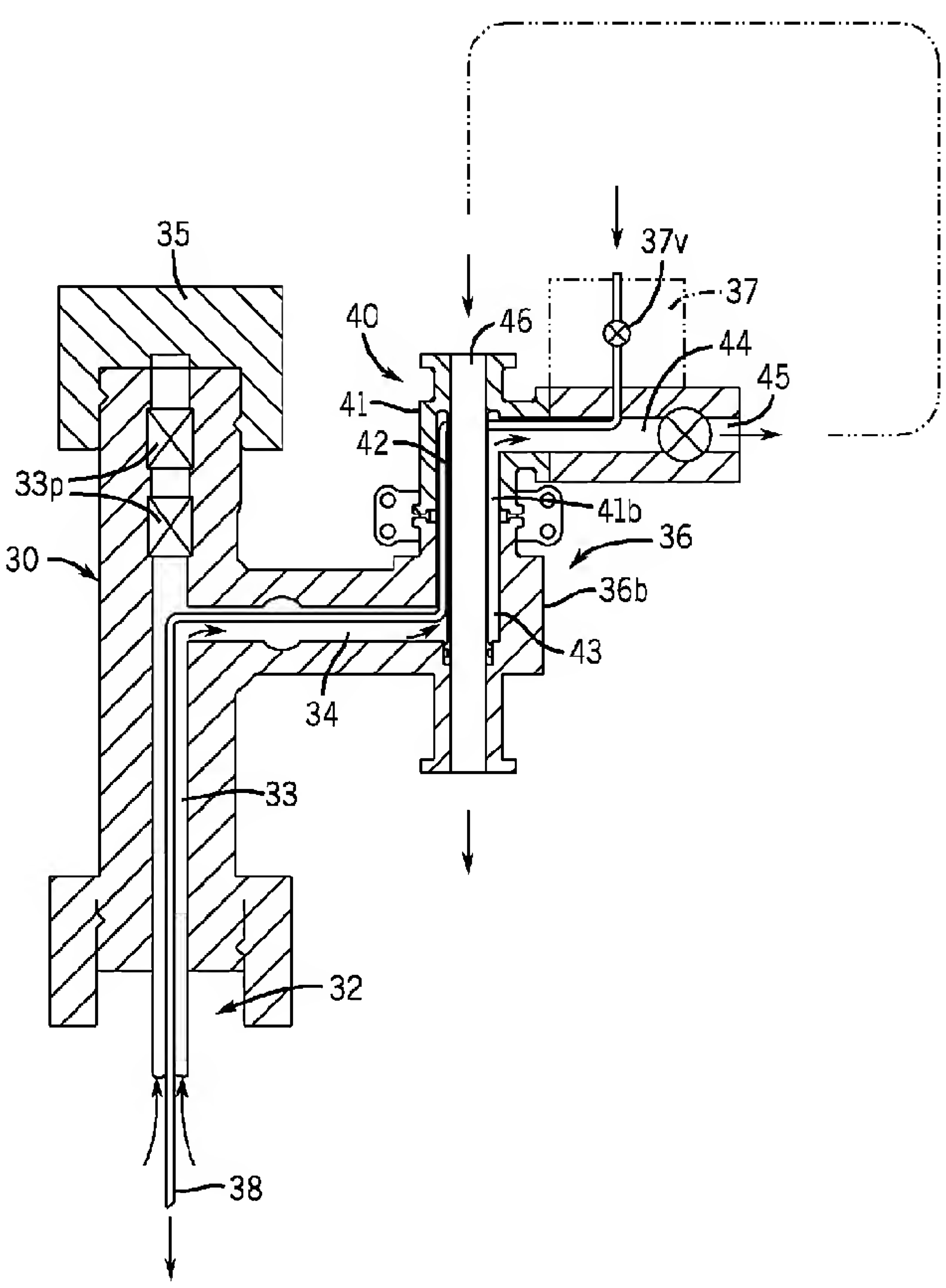
(54) Title: CAPILLARY INJECTOR



(57) Abstract: Provided is a mineral extraction system, including a branch having a branch passage, a diverter coupled to the branch passage, and a capillary injection conduit disposed inside to the branch passage. Further provided is a method of injecting chemicals, including injecting a chemical into a capillary injection conduit disposed internal to a production passage, wherein the chemical injection capillary conduit comprises an inlet and an outlet configured to terminate proximate a well formation.

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CAPILLARY INJECTOR

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Great Britain Provisional Patent Application No. GB0618001.2, entitled “Method”, filed on September 13, 2006, which is herein incorporated by reference.

BACKGROUND

[0002] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present invention, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present invention. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0003] This invention relates to a system and method of treating a well, particularly to an oil, gas or water well. As will be appreciated, oil and natural gas have a profound effect on modern economies and societies. In order to meet the demand for such natural resources, numerous companies invest significant amounts of time and money in searching for and extracting oil, natural gas, and other subterranean resources from the earth. Particularly, once a desired resource is discovered below the surface of the earth, drilling and production systems are employed to access and extract the resource. These systems can be located onshore or offshore depending on the location of a desired resource. Further, such systems generally include a wellhead assembly through which the resource is extracted. These wellhead assemblies generally include a wide variety of components and/or conduits, such as a christmas tree (tree), various control lines, casings, valves, and the like, that control drilling and/or extraction operations.

[0004] As will be appreciated, various control lines or other components of a production or transport system are employed to provide a path for hydraulic control fluid, chemical injections, or the like to be passed through the wellhead

assembly. For instance, chemicals and gases are injected into the well in order to treat scale, wax or other factors that tend to reduce the value, quality or quantity of fluids produced from the well. However, various injection methods may have varying uses and degrees of success. For example, certain systems and methods are suited for a particular style of wellhead or may provide a limited enhancement to the recovery operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Various features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying figures in which like characters represent like parts throughout the figures, wherein:

[0006] FIG. 1 is a cross-sectioned view of an embodiment of a subsea tree in accordance with the present technique;

[0007] FIG. 2 is a cross-sectioned view of a second embodiment of the subsea tree in accordance with the present technique;

[0008] FIG. 3 is a cross-sectioned view of a third embodiment of the subsea tree in accordance with the present technique;

[0009] FIG. 4 is a cross-sectioned view of a fourth embodiment of the subsea tree in accordance with the present technique; and

[0010] FIG. 5 is a cross-sectioned view of a fifth embodiment of the subsea tree in accordance with the present technique.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

[0011] One or more specific embodiments of the present invention will be described below. These described embodiments are only exemplary of the present invention. Additionally, in an effort to provide a concise description of these exemplary embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related

and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0012] According to the present invention there is provided a method of treating a well comprising injecting a chemical into the well in order to enhance recovery of production fluids from the well, wherein the well has a wellhead and a tree located above the wellhead , and wherein the chemical is conveyed to the area of the well to be treated by means of a capillary conduit located in a production bore of the well, with a lower end of the capillary conduit terminating in an outlet for the fluid adjacent to the area of the well to be treated, and wherein an upper end of the capillary conduit terminates in a port for injection of chemicals into the capillary conduit, and wherein the port at the termination of the upper end of the capillary tubing is located above the wellhead.

[0013] In preferred embodiments of the invention the injection port is located on the tree, or on a tree cap. In certain embodiments of the invention, the chemical injection port terminating the upper end of the capillary conduit can be located on a branch of the tree, and typically on a wing branch. In certain embodiments, the chemical injection port can be provided on a choke on the wing branch of the tree. A choke body adapted specifically to accommodate the chemical injection port can optionally be provided, and forms another aspect of the invention.

[0014] The invention also provides apparatus for treating a well comprising a chemical injection line, the chemical injection line comprising a capillary conduit extending from the production zone of the well to the wellhead, and wherein the chemicals are injected through a port located above the wellhead.

[0015] The chemical injection port can comprise a control valve in order to permit injection of the chemicals into the well, but may be adapted to restrain the passage of fluids from the well out through the injection port.

[0016] It may be appreciated that the chemicals can be any suitable chemicals for treating downhole wells, for example scale inhibitors, wax inhibitors etc.

[0017] Typically the well is a subsea well.

[0018] Referring now to FIG. 1, a subsea well has a tree 1 located on a wellhead 2. The tree 1 has a production bore 3 that is connected to production tubing. The production tubing is below the tree 1, and extends to the formation F to convey production fluids from the formation F back to the tree 1 for recovery therefrom. The production bore 3 in the tree 1 has a wing branch 4 through which production fluids are routed by means of valves within the production bore 3 and wing branch 4. A valve V closes the upper end of the production bore 3 of the well 1 beneath a tree cap 5. The wing branch 4 has a choke 6 in order to control the flow of produced fluids through the outlet of the wing branch 4.

[0019] The production bore 3 has a port 7 in a side wall thereof which terminates a capillary conduit 8 that extends between the port 7 and the formation F. In certain embodiments, the capillary conduit 8 is at least substantially or entirely made of titanium or another suitable material. The capillary conduit 8 is intended for use with chemicals intended to treat the well formation F, and conveys the chemicals between the port 7 and the formation F. The port 7 may optionally have a valve 7v in order to control the pressure of chemicals being injected through the port 7 and conduit 8, and to control the back pressure exerted from the formation F.

[0020] In use, the chemicals are injected through the port 7 into the capillary conduit 8 and emerge from the outlet of the capillary conduit 8 in the region of the formation F to be treated with the chemicals. The capillary conduit 8 takes up minimal space within the production bore 3, and does not substantially affect the capacity of the production bore 3, or the production tubing to which it is attached, to convey the production fluids from the formation F to the tree 1. The chemicals injected via the port 7 and the capillary conduit 8 can be used to treat scale, wax, acid or any other undesirable chemicals in the region of the formation F or in other areas of the well that may affect the quality or quantity of

production fluids recovered from the well. Other types of chemical can be deployed by the port 7 and capillary conduit 8.

[0021] The port 7 is located above the wellhead 2 in the region of the side wall of the tree 1. In certain embodiments similar to FIG. 1, the port 7 can be located within the production bore 3, for example, the capillary conduit 8 can terminate within a plug located within the production bore 3, and a side branch can be provided within the plug (and optionally the capillary conduit 8) to facilitate injection of the chemicals into the plug, and thereby into the capillary conduit 8.

[0022] Referring now to FIG. 2, this shows a horizontal style subsea tree 1a, which is similar to the tree 1 shown in FIG. 1, but has a different arrangement of valves to control the flow of production fluids. Typically, the horizontal style tree 1a has a single wing valve 4v, and a number of production bore plugs 3p installed within the production bore 3 above the wing branch 4 and below the tree cap 5. The configuration of the choke 6, the wing branch 4, and the wellhead 2 are identical to that disclosed for the well of FIG. 1. The capillary conduit 8 in the FIG. 2 well terminates within a plug 7p that is located within the production bore 3 below the wing branch 4, but above the wellhead 2. The plug 7p, as previously described provides an axial termination of the capillary conduit 8 within the production bore 3, and provides a lateral injection port 7 extending through the side wall of the production bore 3. In use, the chemicals injected into the tree 1a are injected into the port 7 and through the side wall of the production bore 3, and enter the capillary conduit 8 at the plug 7p.

[0023] FIG. 3 describes a different design of subsea well embodying a capillary injection conduit system. The FIG. 3 well is a typical horizontal tree 10, with the tree plugs 3p having been pulled, the tree cap 5 removed, and a specialized tree cap adapter 15 installed for facilitating the injection of chemicals into the well through the tree 10. The tree 10 is mounted on the wellhead 12 and has a production bore 13 connected to production tubing leading to the formation F as previously described. The production bore 13 has a wing branch 14 with a wing branch valve 14v, and a choke 16 as previously described for the take off of production fluids. The production bore 13 is capped by a tree cap adapter 15 in the form of a cylindrical body 15a with a

pair of plugs 15p that occlude the bore of the body 15a, and a cap 15c, that can optionally be removed to allow access to the plugs 15p and the bore 15b of the body 15, and the production bore 13. The central bore 15b of the body 15a has a conduit through its side wall leading to a port 17 for the injection of chemicals through the side wall conduit and into the bore 15b of the body 15a, which is coaxial with, and a continuation of, the production bore 13. The bore 15b of the body 15a has a plug 18p that terminates the end of a capillary conduit 18 extending from the plug 18p downwards through the bore 15b of the body 15a, and the production bore 13 of the tree 10. In certain embodiments, the capillary conduit 18 is at least substantially or entirely made of titanium or another suitable material. The capillary conduit 18 extends the length of the well and terminates at its lower end within the production bore 13 in the area of the formation F to be treated, typically in the area of the perforated casing at the heal of the well.

[0024] In operation of the FIG. 3 embodiment, chemicals to treat the formation are injected into the port 17, and transfer through the side wall conduit into the bore 15b of the body 15a. They them pass through the plug 18p and capillary conduit 18 into the area of the formation F to be treated. Production fluids are recovered from the production bore in the normal way, which is closed off above the wing branch 14 by means of the plug 18p, and by emergency plugs 15p.

[0025] Referring now to FIG. 4, this illustrates a similar application to a traditional vertical subsea well similar to that shown in FIG. 1 with the production bore valves V removed. The FIG. 4 tree 20 is located on a wellhead 22, and has a production bore 23, a wing branch 24, a choke 26, and a tree cap 15 similar to the tree cap adapter 15 shown in FIG. 3, but with valves 15v instead of plugs 15p. The tree 20 has a capillary conduit 18 terminating in a plug 18p within the bore 15b of the body 15a as previously described, but typically the capillary conduit 18 is surrounded by a perforated cylindrical tube 25 permitting the flow of production fluid from the production bore 23 into the wing branch 24 for recovery as normal, but protecting the capillary conduit 18 from damage by the valves, which may either be removed or remain in place but held open by the tubing 25. With the FIG. 4 embodiment, chemicals used

to treat the formation F are injected through the port 17, through the side wall conduit and into the bore 15b of the body 15a, and through the capillary conduit 18 as previously described, whereas production fluids are gathered from the production tubing into the production bore 23, from where they can flow either inside or outside of the tubing 25 and are diverted into the wing branch 24 for recovery by means of the plug 18p, with provision for containment by the valves 15v and the cap 15c.

[0026] FIG. 5 shows a further embodiment based on a horizontal style of subsea tree 30 similar to that shown in FIG. 2. The tree 30 is secured above a wellhead 32, and has a production bore 33, a wing branch 34 from which the valve has been removed, and a cap 35 installed above two production bore plugs 33p to contain the production fluids within the tree 30.

[0027] The FIG. 5 embodiment has a diverter assembly 40 located partially inside the choke body 36b of the tree 30. In certain embodiments, the diverter assembly 40 is at least substantially or entirely made of titanium or another suitable material. In this embodiment, the internal parts of the choke 36 have been removed, leaving the choke body 36b. Choke body 36b communicates with an interior bore of the wing branch 34. Optionally a further choke can be installed downstream of the choke body 36b, in order to control the flow of fluids from the well.

[0028] The diverter assembly 40 comprises a housing 41 with an axial bore 41b, an inner conduit 42 co-axial with the bore 41b, an inlet 46 and an outlet 45. Housing 41 is substantially cylindrical and in the inner bore 41b extends along its entire length and a connecting lateral passage 44 adjacent to its upper end leads to outlet 45. The housing 41 is adapted to attach to the upper end of choke body 36b by means of a conventional clamp. The conduit 42 is located inside axial passage 41b, creating an annulus 43 between the outside surface of conduit 42 and the inside surface of the axial bore 41b. Conduit 42 extends beyond the housing 41 into the choke body 36b, and past the junction between the wing branch 34 and its perpendicular outlet into which it is sealed just below the junction. Outlet 45 and inlet 46 are typically attached to conduits (not shown) which lead to and from processing apparatus, such as pumps etc., adapted to boost the pressure of the fluids being produced from the well.

[0029] In use, produced fluids come up the production bore 33, enter branch 34 and from there enter annulus 43 between conduit 42 and axial bore 41b. The produced fluids are prevented from going downwards towards the conventional choke outlet by the seals at the lower end of the conduit 42, so they are forced upwards into the annulus 43 and through connecting lateral passage 44 and outlet 45. Outlet 45 typically leads to a processing apparatus (e.g. a pumping or injection apparatus). Once the fluids have been processed, they are returned through a further conduit (not shown) to inlet 46. From here, the fluids pass through the inside of conduit 42 and exit though the conventional outlet of the choke 36, from where they are recovered normally via an export line.

[0030] The capillary injection conduit 38 extends from an injection port 37 through a side wall of the lateral passage 44, through the annulus 43, the wing branch 34, and the production bore 34, into the production tubing and down to the production zone to be treated as previously described. In certain embodiments, the capillary conduit 38 is at least substantially or entirely made of titanium or another suitable material. The chemicals to treat the well formation F are injected from the injection port 37 along this path previously described, while the production fluids are recovered on the same path, but the recovery is substantially unaffected by the narrow diameter of the capillary conduit. In some embodiments, the diverter assembly 40, or the capillary conduit 38, or both, comprise one or more titanium parts, layers, or portions, such that the assembly 40 and/or conduit 38 is at least partially, substantially, or entirely made of titanium.

[0031] While the invention may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

CLAIMS

1. A mineral extraction system, comprising:
   a branch having a branch passage;
   a diverter coupled to the branch passage; and
   a capillary injection conduit disposed inside to the branch passage.

2. The mineral extraction system of claim 1, wherein the diverter comprises a diverter outlet path separate from a diverter inlet path, the diverter outlet path is coupled to a branch inlet path, and the diverter inlet path is coupled to a branch outlet path.

3. The mineral extraction system of claim 1, wherein the diverter comprises an inner conduit that extends into the branch passage to define two independent passages.

4. The mineral extraction system of claim 2, wherein the inner conduit is coaxial with the branch passage to define an annular region between the inner conduit and the branch passage.

5. The mineral extraction system of claim 4, comprising a process loop flowpath that comprises a first path through the annular region and a second path through the inner conduit.

6. The mineral extraction system of claim 4, wherein the capillary injection conduit passes through the annular region.

7. The mineral extraction system of claim 4, wherein the capillary injection conduit passes through the annular region, the branch passage, and a production bore of a tree.

8. The mineral extraction system of claim 1, wherein the diverter comprises a retrofit kit that is disposed in place of a flow control, and the retrofit kit provides a first flowpath that diverts production flow through a diverter output,

and a second flowpath that returns the production flow through a diverter input to a branch output.

9. A chemical capillary injector, comprising:

a chemical injection capillary conduit configured to mount inside a production passage, wherein the chemical injection capillary conduit comprises an inlet and an outlet configured to terminate proximate a well formation.

10. The capillary injector of claim 9, wherein the inlet is configured to terminate into a port disposed on a tree.

11. The capillary injector of claim 9, wherein the inlet is configured to terminate into a port disposed on a tree cap.

12. The capillary injector of claim 9, wherein the inlet is configured to terminate into a port disposed in a branch.

13. The capillary injector of claim 9, wherein at least a portion of the chemical injection capillary conduit is surrounded by tubing inside the production passage.

14. The capillary injector of claim 9, comprising a first flowpath in communication with the production passage and a first outlet, and a second flowpath internal to at least a portion of the first flowpath and in communication with a first inlet and a second outlet, wherein the chemical injection capillary conduit is disposed in the first flowpath.

15. The capillary injector of claim 9, comprising a branch having a branch passage in communication with the production passage, and a diverter coupled to the branch passage and having a diverter outlet passage and a diverter return passage wherein the chemical injection capillary conduit disposed inside the branch passage.

16. A method of injecting chemicals, comprising:

injecting a chemical into a capillary injection conduit disposed internal to a production passage, wherein the chemical injection capillary conduit comprises an inlet and an outlet configured to terminate proximate a well formation.

17. The method of claim 16, wherein injecting comprises flowing the chemical in a direction opposite to production flow through the production passage.

18. The method of claim 16, wherein injecting comprises outputting the chemical into the formation via the outlet of the capillary injection conduit.

19. The method of claim 16, comprising flowing production fluid via an annular region of the production passage surrounding the capillary injection conduit.

20. The method of claim 16, wherein injecting comprises routing the chemical through the capillary injection conduit disposed at least partially inside a diverter.

21. The method of claim 20, wherein routing comprises flowing the chemical through the capillary injection conduit inside an annular region between coaxial conduits of the diverter.

22. The method of claim 20, comprising diverting production flow through the diverter mounted at least partially inside a branch of a well, wherein diverting comprises redirecting the production flow through a first outlet, returning the production flow through a first inlet, and outputting the production flow through a second outlet.

23. A diverter, comprising:

a diverter having an output and return passages both configured to couple to a branch passage of a mineral extraction system; and

a capillary injection conduit configured to be disposed internal to the branch passage.

24. A christmas tree, comprising:

a tree body having a production passage; and

an injection capillary conduit disposed at least partially inside an along the production passage, wherein the injection capillary conduit comprises an inlet and an outlet configured to terminate proximate a well formation.

25. The christmas tree of claim 24, comprising a diverter having an inner conduit having a conduit passage locatable internal to a branch passage of the christmas tree, wherein the diverter, or the injection capillary conduit, or both, are at least substantially made of titanium.

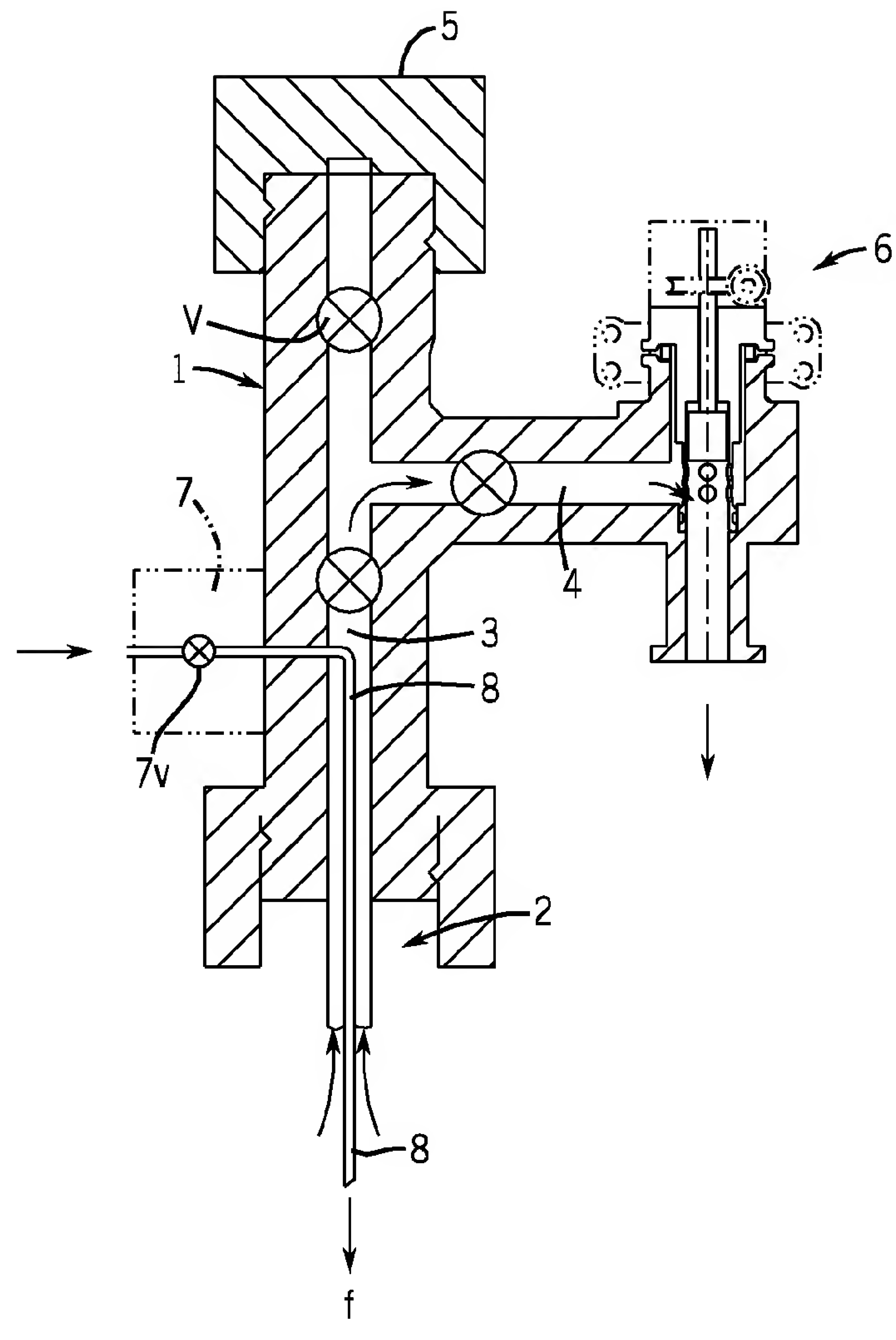

FIG. 1

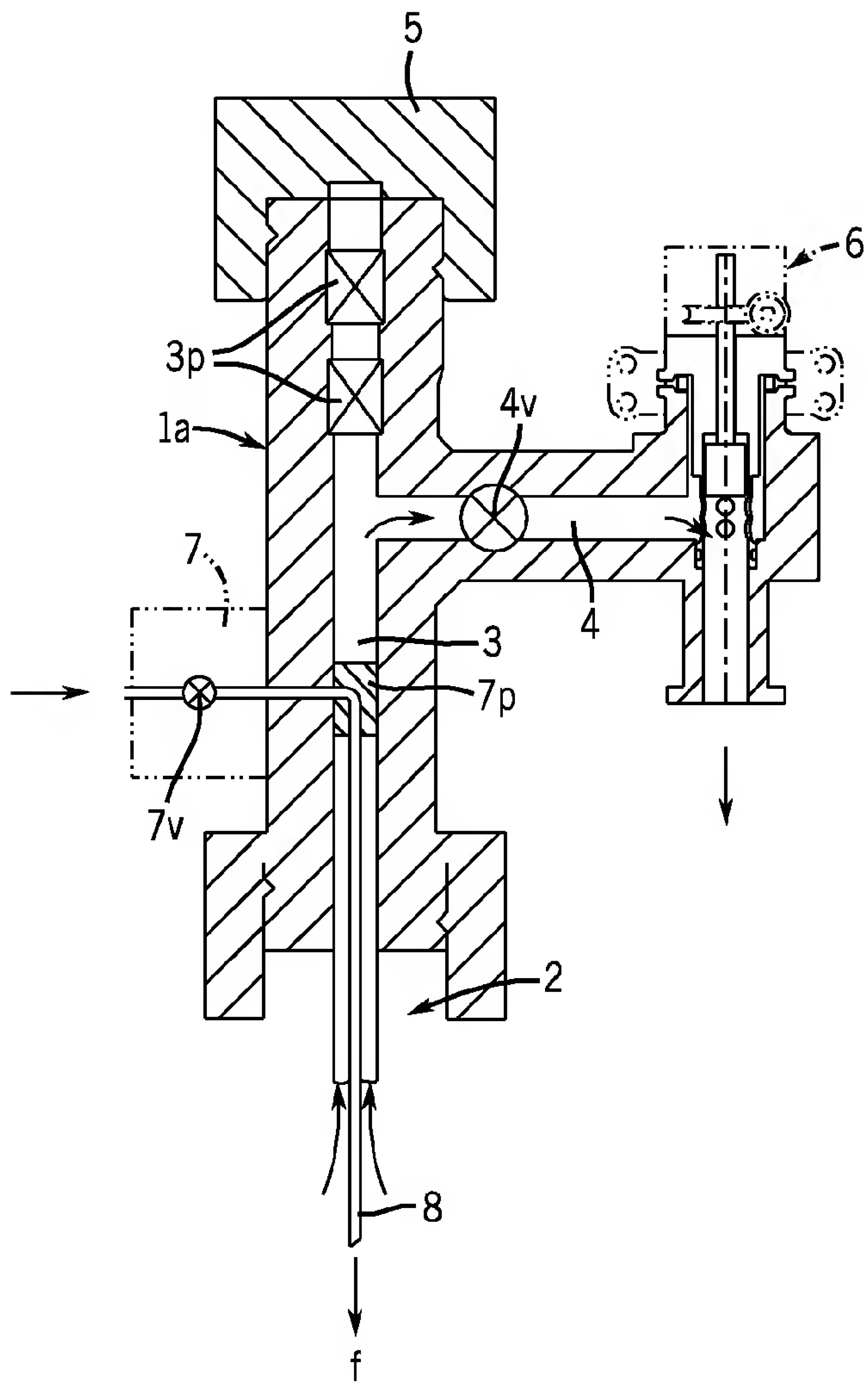

FIG. 2

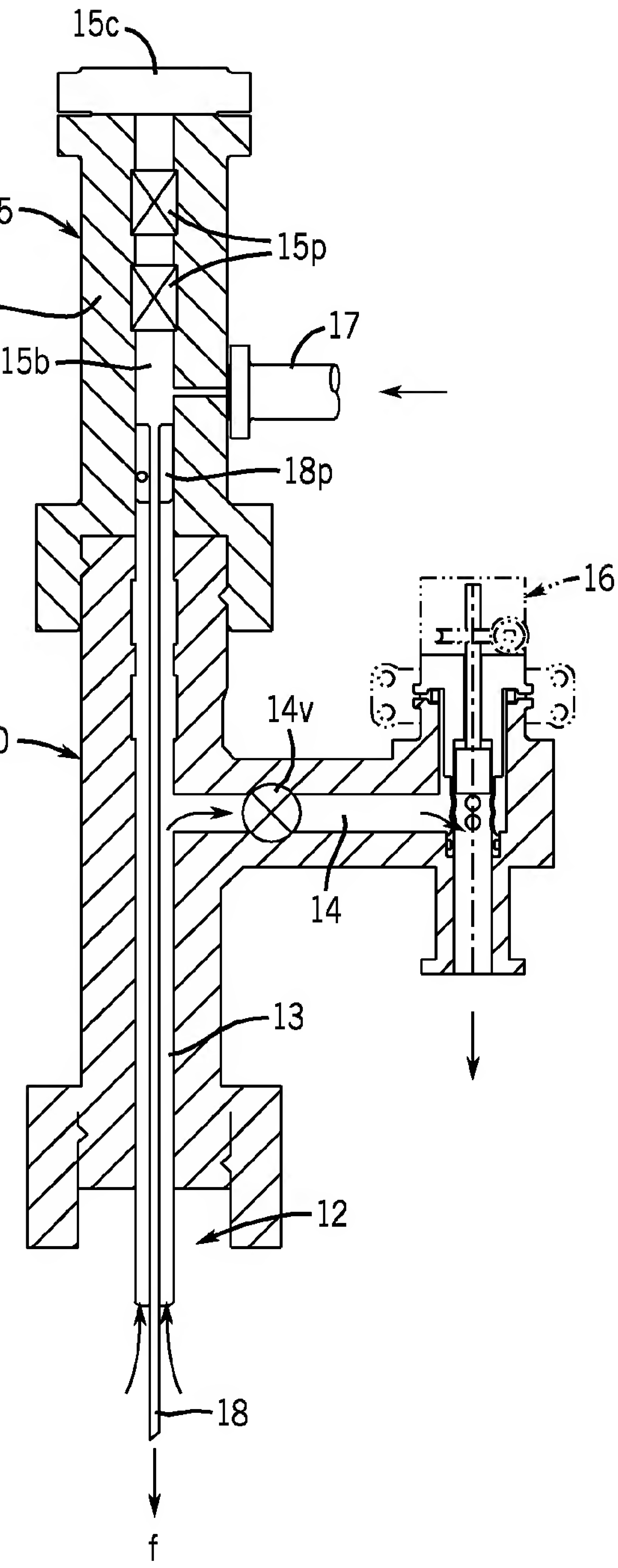

FIG. 3

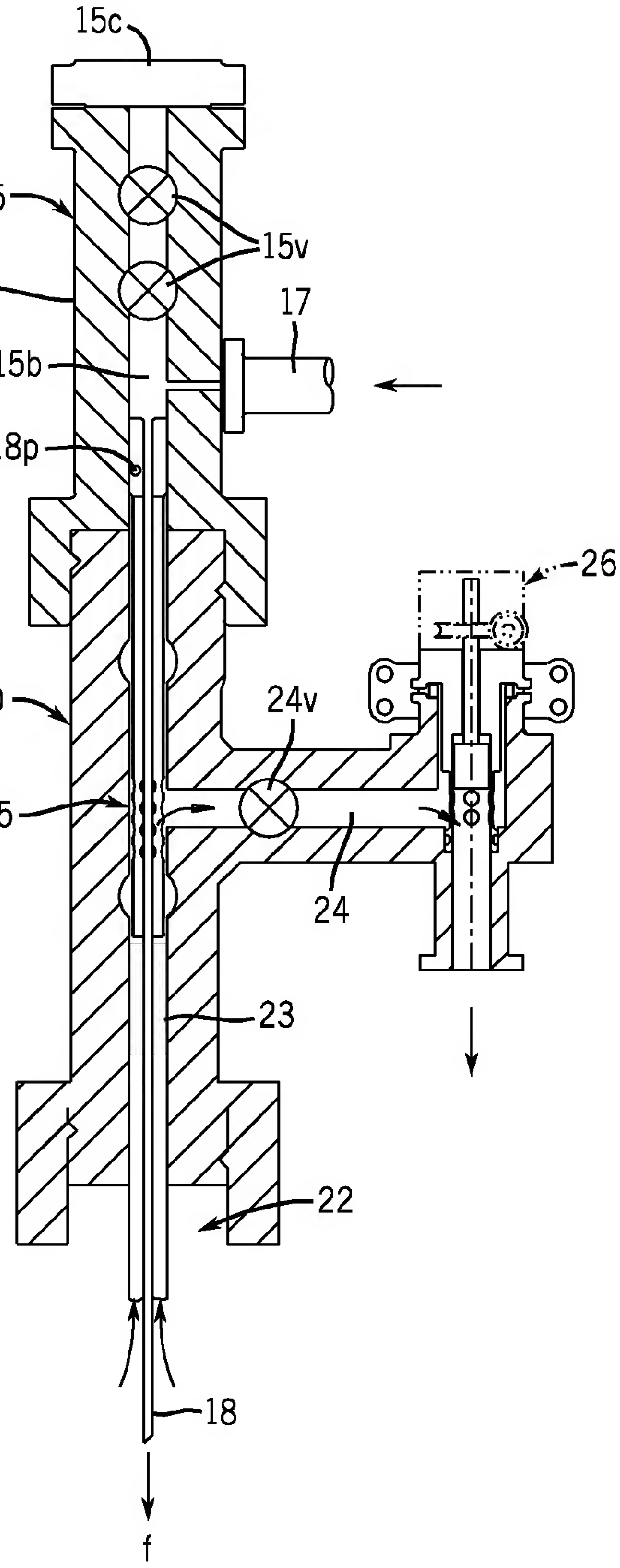

FIG. 4

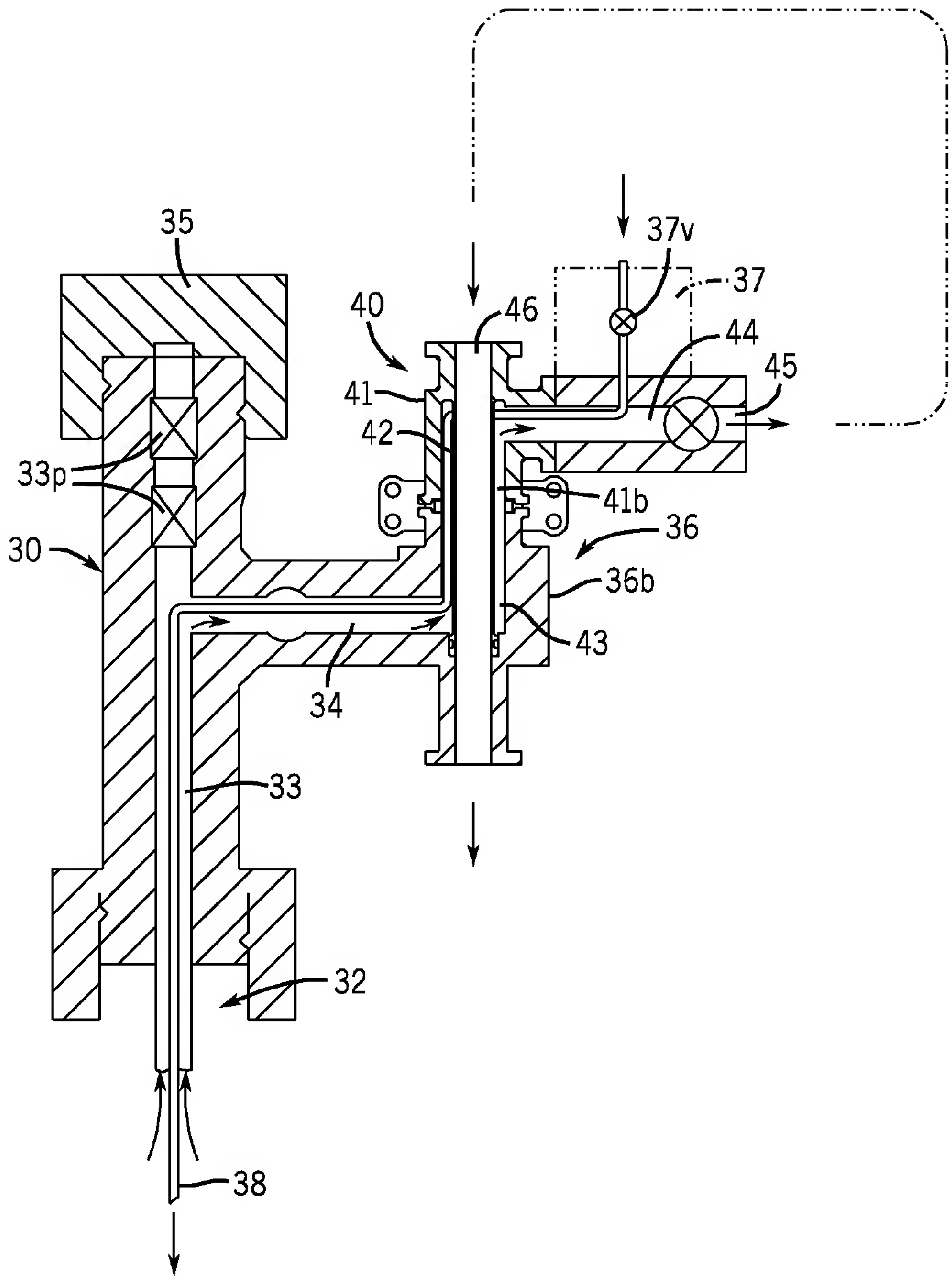

FIG. 5